## AD-A215 160 ON-PAGE

form Approved OMB No. 0704-0188

			PORT TYPE AND DATES COVERED Final (9/1/82-8/30/83	
TITLE AND SUBTITUE	<del></del>	rinai (9/1	/82-8/30/83	
, the ARD SUBTILE			)	
PROBABILISTIC ANALYSIS	OF ALGORITHMS FOR	NP-COMPLETE		
PROBLEMS			61102F	
AUTHOR(S)			2304/A2	
John Franco			ł	
			ł	
. PERFORMING ORGANIZATION NAME		<del></del>	8. PERFORMING ORGANIZATION REPORT NUMBER	
Case Western Reserve Ur			REPORT NUMBER	
Computer Engineering and Cleveland OH 44106	nd Science Departme	ent .	R. 89-1475	
Creverand OH 44106		Whom.		
			<u> </u>	
. SPONSORING/MONITORING AGENC	Y NAME(S) AND ADDRESSES	TIG	10. SPONSORING/MONITORING AGENCY REPORT MUMBER	
AFOSR	U	CTE		
BLDG 410	EL.	ECTE 3 0 5 1989	<u> </u>	
BAFB DC 20332-6448	DE C	202 1802	AFOSR-82-0331	
	Dr.			
11. SUPPLEMENTARY NOTES				
·		0		
	•	r	•	
2a. DISTRIBUTION/AVAILABILITY STA	TEMENT		12b. DISTRIBUTION CODE	
			1	
. 0704	Compatible		i	
			-	
a neriba	Wienerstein bei der		į.	
0.19 <b>trib</b> 1.	lienast (),			
13. ABSTRACT (Maximum 200 words)				
3. ABSTRACT (Maximum 200 words) During this period the	investigator produ	ced papers with	titles, "Duality, finite	
3. ABSTRACT (Maximum 200 words) During this period the improvement and efficie	investigator produ	zation problems.	titles, "Duality, finite " "Swnsitivity of probabi	
3. ABSTRACT (Maximum 200 worth) During this period the improvement and efficie listic results on algor	investigator produently solved optimi	zation problems	""Swnsitivity of probabi	
3. ABSTRACT (Maximum 200 worth)  During this period the improvement and efficie listic results on algor a third, being written	investigator produently solved optimicithm for NP-comple	zation problems te problems to c analysis of a	" "Swnsitivity of probabi input distribution," and gorithms for the satisfia	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh	investigator produently solved optimicithm for NP-complenow, "Probabilisti	zation problems te problems to c analysis of al hly unlikely tha	""Swnsitivity of probabi input distribution," and lgorithms for the satisfia at an NP-complete problem	
During this period the improvement and efficie listic results on algor a third, being written problem. The first she can be solved by any of	investigator production in the solved optimic rithm for NP-comple now, "Probabilisti tows that it is high a certain broad c	zation problems te problems to c analysis of al hly unlikely tha lass of algorith	""Swnsitivity of probabi input distribution," and lgorithms for the satisfia at an NP-complete problem nms. The second shows tha	
During this period the improvement and efficie listic results on algor a third, being written problem. The first she can be solved by any of favorable results on a input distribution is u	investigator production in the for NP-comple now, "Probabilisti lows that it is high a certain broad cortain set of prosect of the algorithms	zation problems te problems to c analysis of a hly unlikely tha lass of algorith blems are mislea perform badly	""Swnsitivity of probabi input distribution," and lgorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the	investigator production for NP-completions, "Probabilisting tows that it is high a certain broad cortain set of prosed the algorithms third is that the	zation problems te problems to c analysis of al hly unlikely tha lass of algorith blems are misles perform badly is	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved	investigator production for NP-completions, "Probabilistinows that it is high a certain broad cortain set of prosed the algorithms third is that the efficiently in the	zation problems te problems to c analysis of al hly unlikely tha lass of algorith blems are misles perform badly i satisfiability probabilistic	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete gense under a distribution	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete gense under a distribution	
3. AssTRACT (Maximum 200 worth) During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete gense under a distribution	
3. Assmact (Maximum 200 work)  During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete gense under a distribution	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete gense under a distribution	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead conducted under the gra	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabi input distribution," and gorithms for the satisfia at an NP-complete problem mms. The second shows tha ading. That is if another in the probabilistic sense problem, an NP-complete gense under a distribution	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead conducted under the gra	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabiling the distribution," and agorithms for the satisfiant an NP-complete problem and the second shows that adding. That is if another in the probabilistic sense problem, an NP-complete sense under a distribution as results of research	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead	investigator production to solved optimition of the for NP-completion on the form of the following that it is high a certain broad contain set of produced the algorithms third is that the efficiently in the ling results. The	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabilingut distribution," and agorithms for the satisfial at an NP-complete problem and the second shows that adding. That is if another an the probabilistic sense problem, an NP-complete sense under a distribution as results of research	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead conducted under the gra	investigator production for NP-completions, "Probabilisticows that it is high a certain broad cortain set of prosed the algorithms third is that the efficiently in the ing results. The int during the incl	zation problems te problems to c analysis of al hly unlikely tha lass of algorith blems are misles perform badly i satisfiability p probabilistic s report summarize usive dates.	""Swnsitivity of probabiling the distribution," and agorithms for the satisfiant an NP-complete problem and the second shows that it is if another and the probabilistic sense problem, an NP-complete sense under a distribution as results of research  15. NUMBER OF PAGES  2 16. PRICE COOL	
During this period the improvement and efficie listic results on algor a third, being written problem. The first sh can be solved by any of favorable results on a input distribution is u The main result in the problem, can be solved which causes no mislead conducted under the gra	investigator producently solved optimicithm for NP-comple now, "Probabilistimows that it is high a certain broad cortain set of proposed the algorithms third is that the efficiently in the ling results. The lant during the incl	zation problems te problems to c analysis of al hly unlikely the lass of algorith blems are misles perform badly is satisfiability p probabilistic s report summarize	""Swnsitivity of probabiling the distribution," and agorithms for the satisfiant an NP-complete problem and the second shows that it is if another and the probabilistic sense problem, an NP-complete sense under a distribution as results of research  15. NUMBER OF PAGES  2 16. PRICE COOL	

89 11 29 Standard Form 298 (890104 Draft)

PROBABILISTIC ANALYSIS OF ALGORITHMS

FOR NP-COMPLETE PROBLEMS

AFOSR Contract AFOSR-82-0331

JOHN FRANCO, Principal Investigator
CASE WESTERN RESERVE UNIVERSITY

Scientific Report September, 1983

Accession For  RTIS GRAAI DTIC TAB Unannounced Justification		
Ava	lability Codes	
Dist	Avail and/or Special	
A-1		

The first year of this project has resulted in material for three papers and this material was presented to about 40 members of the technical staff at the Institute for Defense Analysis. Two papers which have already been written are "Duality, Finite Improvement and Efficiently Solved Optimization Problems" and "Sensitivity of Probabilistic Results on Algorithms for NP-Complete Problems to Input Distribution". A third paper tentatively entitled "Probabilistic Analysis of Algorithms for the Satisfiability Problem" is being written now. The first paper shows that it is highly unlikely that an NP-complete problem can be solved by any of a certain broad class of algorithms. This statement has a negative impact on probabilistic results for NP-complete problems. The second paper presents some very favorable probabilistic results based on some commonly used input distributions. These results are obtained for extremely simple-minded algorithms based on techniques like search rearrangement. Some of these results were obtained by us and some by others. It is shown that in all the cases presented there is something misleading about the favorable results and that if another distribution F is used the algorithms perform badly in the probabilistic sense. The third paper presents algorithms which seem to perform well

under F in probability. Some of these algorithms are analyzed mathematically and some are analyzed empirically. The main result of this paper is that the satisfiability problem, an NP-complete problem, can be solved efficiently in the probabilistic sense under a distribution which causes no known misleading results.

The two talks that were presented to the Institute for Defense Analysis were based on the second and third papers.

The first paper was recently presented at the semi-annual Midwest
Theory Conference and was recently submitted to Mathematics of Operations
Research. The second paper was submitted to the Journal of the
Association for Computing Machinery in September, 1983. All three
papers will be sent to AFOSR in February or early March along with a
more detailed report of progress.